The vibrations of light are not such as can be transmitted by a set of disconnected molecules; if by molecules at all, it must be by molecules connected into a solid, *i.e.* by a body with rigidity. Rigidity means active resistance to shearing stress, *i.e.* to alteration in shape; it is also called *elasticity of figure*; it is by the possession of rigidity that a solid differs from a fluid. For a body to transmit vibrations at all it must possess inertia; transverse vibrations can only be transmitted by a body with rigidity. All matter possesses inertia, but fluids only possess volume elasticity, and accordingly can only transmit longitudinal vibrations. Light consists of transverse vibrations; air and water have no rigidity, yet they are transparent, *i.e.* transmit transverse vibrations; hence it must be the ether inside them which really conveys the motion, and the ether must have properties which, if it were ordinary matter, we should style *inertia* and *rigidity*. No highly rarefied air will serve the purpose; the ether must be a distinct body. Air *exists* indeed in planetary space even to infinity, but it is of almost infinitesimal density compared with the ether there. It is easy to calculate the density of the atmosphere at any height above the earth's surface, supposing other bodies absent.

The density of the air at a distance of n earth radii from the centre of the earth is equal to a quarter the density here divided by $10^{350\frac{n-1}{n}}$. So at a height of only 4000 miles above the surface, the atmospheric density is a number with 127 ciphers after the decimal point before the significant figures begin. The density of ether, on the other hand, has been calculated by Sir William Thomson from data furnished by Pouillet's experiments on the energy of sunlight, and from a justifiable guess as to the amplitude of a vibration, and it comes out about 10^{-18}, a number with only 17 ciphers before the significant figures. In inter-planetary space, therefore, all the air that exists is utterly negligible; the density of the ether there, though small, is enormous by comparison.

Once given the density of the ether, its rigidity follows at once, because the ratio of the rigidity to the density is the square of the velocity of transverse wave propagation, viz. in the case of ether, 9×10^{20}. The rigidity of ether comes out, therefore, to be about 900. The most rigid solid we know is steel, and compared with its rigidity, viz. 8×10^{11}, that of ether is insignificant. Neither steel nor glass, however, could transmit vibrations with anything like the speed of light, because of their great density. The rate at which transverse vibrations are propagated by crown glass is half a million centimetres per second —a considerable speed, no doubt, but the ether inside the glass transmits them 40,000 times as quick, viz. at twenty thousand million centimetres per second.

The ether outside the glass can do still better than this, it comes up to thirty thousand million, and the question arises what is the matter with the ether inside the glass that it can only transmit undulations at two-thirds the normal speed. Is it denser than free ether, or is it less rigid? Well, it is not easy to say; but the fact is certain that ether is somehow affected by the immediate neighbourhood of gross matter, and it appears to be concentrated inside it to an extent depending on the density of the matter. Fresnel's hypothesis is that the ether is really denser inside gross matter, that there is a sort of attraction between ether and the molecules of matter which results in an agglomeration or binding of some ether round each atom, and that this additional or bound ether belongs to the matter, and travels about with it. The *rigidity* of the bound ether Fresnel supposes to be the same as that of the free.

If anything like this can be imagined, a measure of the density of the bound ether is easily given. For the inverse velocity-ratio is called μ (the index of refraction), and the density is inversely as the square of the velocity, hence the density-measure is μ^2. The density of ether in free space being called 1, that inside matter has a density μ^2, and the density of the bound portion of this is $\mu^2 - 1$.

This may all sound very fanciful, but something like it is sober truth; not as it is here stated very likely, but the fact that $\left(1 - \frac{1}{\mu^2}\right)$th of the whole ether inside matter is bound to it and travels with it, while the remaining $\frac{1}{\mu^2}$th is free and blows freely through the pores, is fairly well established and confirmed by direct experiment.

(*To be continued.*)

UNIVERSITY AND EDUCATIONAL INTELLIGENCE

CAMBRIDGE.—The following further announcements of lectures have been made:—

Prof. Humphry, Circulatory and Respiratory Systems, Jan. 25; senior class, Jan. 29; Demonstrations by the Demonstrator for Natural Science Tripos, Jan. 26; Osteology, for beginners, Jan. 17; Demonstrations for second year students, Jan. 18; Mr. McAlister will give six lectures later in the term, on the Mechanism of the Human Skeleton. Dr. Michael Foster's course of Elementary Physiology, Jan. 23; Mr. Lea, Chemical Physiology, Jan. 24; Dr. Vines, Anatomy of Plants, advanced, with practical work, Jan. 24 (Christ's College); General Elementary course, New Museums, Jan. 23, to extend over two terms, and be illustrated by demonstrations. A class for the practical study of systematic botany, Mr. T. H. Corry, assistant curator of the Herbarium, will be formed. Dr. Hicks will lecture on the Morphology of Flowering Plants, with especial reference to classification, including floral diagrams, in the Hall of Sidney College, beginning Jan. 26; Mr. Glazebrook, advanced Demonstrations in Electricity and Magnetism, Cavendish Laboratory, Jan. 24; Mr. Shaw, Demonstrations in Mechanics and Heat, Jan. 23; if more students attend than can be accommodated in the laboratory at one time, the course will be repeated on the same days. Mr. Trotter, Trinity College, Physical Optics, Jan. 25. Mr. Pattison Muir, Non-metallic Elements, Elementary, Jan. 22, Caius College Laboratory; General Principles of Chemistry, Advanced, Jan. 23. Mr. Solly will give Demonstrations on Minerals in the Lecture Room of the Mineralogical Museum, first lecture, Jan. 22. Prof. Stuart, Jacksonian Lecture Room, Theory of Structures, Jan. 30; the Demonstrator of Mechanism, Mathematics required for Engineering, Jan. 29.

Christ's College Open Scholarships, Natural Science; E. L. Sortain, Bath College, 30*l.*; 3rd year, J. C. Bose, 30*l.*; Caius College, Natural Science, Edgworth, Clifton College, 40*l.*

MR. MARSHALL WARD is giving a course of free public lectures at Owens College, on the Nutrition of Plants.

SCIENTIFIC SERIALS

Journal of the Franklin Institute, January.—Electric lighting in mills, by C. J. H. Woodbury.—Bricks and brick-making machinery, by C. Chambers, Jun.—Experiential principles of controlled combustion, by E. J. Mallett, Jun.—Olsen's testing machines.

Archives des Sciences Physiques et Naturelles, December 15, 1882.—Meteorological *résumé* of the year 1881 for Geneva and the great St. Bernard, by A. Kammermann.—Observations on cometary refraction, by W. Meyer.—Development of the vegetable kingdom in different regions since the tertiary epoch, according to Dr. Engler's work, by A. de Candolle.—Periodical movements of the air indicated by spirit levels, by Ph. Plantamour.—On the same, by C. von Orff.

SOCIETIES AND ACADEMIES

LONDON

Chemical Society, January 18.—Dr. Gilbert, president, in the chair.—It was announced that a ballot for the election of fellows would be held at the next meeting, February 1.—The following papers were read:—The fluorine compounds of uranium, by A. Smithells. The author has investigated the action of aqueous hydrofluoric acid upon the green uranoso-uranic oxide. He finds that a voluminous green powder, uranium tetrafluoride, is left, and that a yellow solution is formed which contains uranium oxyfluoride. The author confirms the results previously obtained by Bolton, and proves those obtained by Ditte to be erroneous.—On a new method of estimating the halogens in volatile organic compounds, by R. T. Plimpton and E. E. Graves. The authors burn the vapour of the compound in a glass Bunsen burner, the products of the combustion are aspirated through caustic soda solution, which is heated with sulphurous acid and the halogen precipitated by silver nitrate, &c., in the usual way. Good results were obtained with various liquids from ethyl bromide boiling at 39° to acetylene bromiodide boiling at 150°.—On a modified Liebig's condenser, by W. A. Shenstone. The author has slightly modified a vertical con

denser so that it can be used for prolonged digestion and subsequent distillation without shifting.—On two new aluminous mineral species Evigtokite and Liskeardite, by W. Flight.—On the volume alteration attending the mixture of salt solutions, by W. W. J. Nicol. The salts employed were NaCl, KCl, KNO_3, $NaNO_3$, $CuSO_4$ and K_2SO_4.

Zoological Society, January 16.—Prof. W. H. Flower, F.R.S., president, in the chair.—Mr. H. E. Dresser, F.Z.S., exhibited and made remarks on a specimen of *Merops philippensis*, which was said to have been obtained near the Snook, Seaton Carew, in August, 1862.—Lieut.-Col. Godwin-Austen, F.R.S., read the third and concluding of a series of papers on the shells which had been collected in Socotra by Prof. J. Bayly Balfour. The present portion treated of the freshwater shells of Socotra, which were stated all to belong to the genera *Planorbis*, *Hydrobia*, and *Melania*. Not a single bivalve was obtained. Four species were described as new, namely, *Planorbis socotrensis*, *P. cockburni*, *Hydrobia balfouri*, and *Melania sclateri*.—Prof. E. Ray Lankester, F.R.S., read a paper on the right cardiac valves of *Echidna* and of *Ornithorhynchus*. Seven additional specimens of the latter animal had been examined since the author's former paper on this subject had been read, all of which, whilst showing interesting variations, agreed in the absence of the septal flap of the right cardiac valve. This character was shown to exist also in *Echidna*, and was therefore presumed to be a distinctive feature in the structure of the Monotremes.—A communication was read from Mr. F. Moore, F.Z.S., containing the descriptions of some new genera and species of Asiatic Lepidoptera Heterocera.—A communication was read from Mr. G. B. Sowerby, jun., in which he gave the descriptions of five new species of shells from various localities.

Anthropological Institute, January 9.—Mr. A. J. Lewis in the chair.—The election of Admiral F. S. Tremlett, F.R.G.S., was announced.—Mr. Worthington G. Smith exhibited four palæolithic implements from Madras. One of them weighed 4 lbs. $7\frac{3}{4}$ oz., and the author believed that it was the second largest specimen of the kind extant.—Mr. W. S. Duncan read a paper on the probable region of man's evolution. Starting with the assumption that man was evolved from a form lower in organisation than that of the lowest type yet discovered, and that his origination formed no exception to the general law of evolntion recognised as accounting for the appearance of the lower forms of life, the author said that man's most immediate ancestors must have been similar in structure to that of the existing Anthropoid apes, although it is not necessary to suppose that any of the Anthropoid apes at present existing belong to the same family as that of man. The science of the distribution of animals showed that the higher types of monkeys and apes appear to have had their origin in the Old World, the American continent being entirely destitute of them, either alive or fossil. The distribution of the greater portion of the animals of the Old World was shown to have taken a generally southward direction, owing to the gradual increase of the cold, which culminated in the last Ice Age. This migration was, however, interrupted by the interposition of the Mediterranean and other seas, and thus, although a few of these animals were enabled to journey on until they reached tropical regions, the majority were compelled to remain behind, where they had to exist under altered circumstances. The temperature was much lower, and as a result of the consequent diminution of the number of fruit forests, a change in the food and in the manner in which it was obtained by the apes occurred. A considerable alteration took place also in the manner in which they were forced to use their limbs, and it was due to the operation of these and other causes that the ape form became stamped with human characteristics such as the curvature of the spine and an increase in the breadth of the pelvis. For these reasons the author regarded the south of Europe as the part in which it was most likely that the evolution of man took place. Mr. Duncan concluded by urging the importance of forming a committee to watch discoveries bearing on this branch of anthropology.

Meteorological Society, January 17.—Annual General Meeting.—Mr. J. K. Laughton, F.R.A.S., President, in the chair.—The Secretary read the Report of the Council which showed that the total number of Fellows was 571, 47 new Fellows having been elected during the year.—The President then delivered his Address. He referred briefly to the great importance of the uniform series of observations now taken under the auspices of the Society, and proceeded to speak, at greater length, of certain other points in which the Society might, by its concerted action, further the interests of meteorological science. The first of these was anemometry, which is at present in a condition far from satisfactory. We know nothing positively either as to the pressure or the velocity of the wind; there is no exact standard instrument, and observations, whatever may be their absolute value, are not comparable one with the other. He thought that the Society might properly interfere, so far as to regulate the wide diversity amongst the instruments now used, in order that when the proper time came, and it was known what anemometer could be trusted, the older observations might be reduced. The movement of air in the upper regions of the atmosphere is not measurable by any existing method; but experiments have been made, at the suggestion of the Meteorological Council, in which the drift of the smoke-cloud of a bursting shell may be observed and measured. The observations of the barometer taken at elevated stations in the United States seem to throw considerable doubt on the received formulæ for the reduction of barometric readings to sea-level, and for the calculation of heights. When the observations extend over a long period, and are regularly taken under all conditions of weather, then no doubt the height of a mountain can be calculated with a fair approach to accuracy; but isolated observations, subject to the fluctuations of the different readings are extremely wild in their results. In the same way, the reduction of the barometer to sea-level is complicated by many discrepancies which arise between observations at the upper and lower stations, which have hitherto been ignored. It is impossible to say how far they affect the isobars on which our daily weather charts are based; but it is probable that they are at least one additional source of error and of difficulty. It is much to be wished that systematic and continuous observations at high-level stations could be taken, not only on the top of Ben Nevis, but on the top of some others of the highest peaks in different parts of the country. In this way alone, can these difficulties of reduction be cleared away.—The following gentlemen were elected the Officers and Council for the ensuing year:—President, John Knox Laughton, F.R.A.S., Vice-Presidents: Edmund Douglas Archibald, M.A., Rogers Field, B.A., Baldwin Latham, F.G.S., William Marcet, F.R.S., Treasurer, Henry Perigal, F.R.A.S., Trustees: Hon. Francis Albert Rollo Russell, Stephen William Silver, F.R.G.S., Secretaries: George James Symons, F.R.S., John William Tripe, M.D., Foreign Secretary, Robert Henry Scott, F.R.S., Council: Hon. Ralph Abercromby, William Morris Beaufort, F.R.A.S., John Sanford Dyason, F.R.G.S., Henry Storks Eaton, William Ellis, F.R.A.S., Joseph Henry Gilbert, F.R.S., Charles Harding, Robert John Lecky, F.R.A.S., Capt. John Pearse Maclear, R.N., Edward Mawley, F.R.H.S., George Matthews Whipple, F.R.A.S., Charles Theodore Williams, M.D.

EDINBURGH

Royal Society, January 15.—Prof. Maclagan, vice-president, in the chair.—In a paper on the diurnal variation of the force of the wind on the open sea and near land, Mr. Buchan gave the first instalment of the meteorological results of the *Challenger* expedition. From fully 1200 observations which had been taken, mean diurnal curves were drawn for the different oceans, from which it appeared that in the open sea no clear marked diurnal variation existed, but that near land a very evident maximum showed itself about two in the afternoon, and a much smaller maximum at midnight. Also near land the force of the wind was distinctly less than in the open sea, a fact readily accounted for by the greater friction experienced at the surface in the former case. The wind was strongest in the southern ocean, feeblest in the Pacific. Though the temperature observations had not been completely reduced, enough had been done to show that the surface temperature of the North Atlantic was subject to a very small variation of not more than ·75 of a degree Fahrenheit.—The Rev. Dr. Teape read a long paper on the Semitic and Greek article, in which he pointed out the influence of the Hebrew idiom upon the use of the Greek article, both in the Septuagint and the New Testament, and maintained, in opposition to Prof. Blackie's views, that the use of the Greek article was regulated by definite grammatical rules.—Mr. W. W. J. Nicol, M.A., B.Sc., read a paper on the nature of solution, which he regarded from the point of view of molecular attraction. Solution took place because the particles of water had a greater attraction for the particles of the salt than these had for themselves. The theory was applied to explain various facts

established by himself and other experimenters, such for example as the relation between the density of a crystal and the temperature at which it is made to crystallise out.—An elaborate experimental paper on the relative electro-chemical positions of wrought iron, steels, cast metal, etc., in sea-water and other solutions by Mr. Thomas Andrews, Assoc.M.Inst.C.E., F.C.S., was communicated by Prof. Crum Brown. The time changes in the galvanic relations were very curious, showing in some instances a complete reversal of the poles. This was regarded as probably due to the penetration of the liquid into the plates, which would thus seem to be very far from homogeneous. The experiments have evidently an important bearing on the question of erosion in sea-water.

SYDNEY

Linnean Society of New South Wales, October 25, 1882.—Dr. James C. Cox, F.L.S., &c., president, in the chair. —The following papers were read:—Description of a new species of *Solea* from Port Stephens, by E. P. Ramsay, F.L.S. This new species of sole, of which a drawing was exhibited, was proposed to be named *S. lineata*.—Contributions to Australian oology (continuation), by E. P. Ramsay, F.L.S. In this paper the author gave descriptions of the nests and eggs of nineteen additional species of Australian birds, whose nidification and oology had previously been imperfectly known.—Descriptions of Australian Micro-lepidoptera, by E. Meyrick, B.A. This, the eighth paper by Mr. Meyrick on the Micro-lepidoptera of this country, treats exclusively of the *Oecophoridæ*, a family represented in Australia by about 2000 species. Fifteen genera and 107 species are described at great length in the present paper.—Notes on the geology of the Western coal-fields, by Prof. Stephens, M.A., No. 1. This was a brief account of the Wallerawang and Capertee conglomerates and overlying coal-measures, together with some description of the Devonian beds of the Capertee Valley and Coco Creek. Specimens of *Brachiopoda* and *Favosites*, together with a large *Pleurotomaria* as well as of Porphyry and other rocks obtained from the same locality were shown in illustration of the paper.—Notes on the oyster beds at Cape Hawke, by James C. Cox, M.D., &c. This was a paper in support of the author's views, as expressed in a previous paper, of the undoubted specific difference between the drift oyster and rock oyster of our coasts.

PARIS

Academy of Sciences, January 15.—M. Blanchard in the chair.—The following papers were read:—Choice of a first meridian, by M. Faye (Report in name of Commission). This is favourable to the American proposal.—On the mechanical and physical constitution of the sun (first part), by M. Faye. He presents a *résumé* of his researches on the subject.—Researches on alkaline sulphites, by M. Berthelot.—On alkaline hyposulphites, by the same.—On complex units, by M. Kronecker.—Separation of gallium (continued), by M. Lecoq de Boisbaudran.—Table concerning the ramification of *Isatis tinctoria*, by M. Trécul.—On hydraulic silica, and on the *rôle* it plays in the hardening of hydraulic compounds, by M. Landrin. The pure silica obtained by decomposing a solution of silicate of potash with an acid, and repeatedly washing and drying at a dark red heat, he names *hydraulic silica*, and he considers it the cause of the final hardening of hydraulic mortars. The aluminate of lime cannot concur in this effect, because of solubility, but at the moment of immersion it facilitates the intimate union of the hydraulic elements, hinders water from penetrating the mass of mortar, and so aids the slow reciprocal action of the lime and hydraulic silica.—Chemical studies on maize, &c. (continued), by M. Leplay.—Treatment of typhoid fever at Lyons, in 1883, by M. Glénard. Instead of the *expectant* method, which awaits complications, combating them as they arise, the method of treatment with cold baths has been adopted in Lyons (as in Germany), with a view to preventing those complications. The mortality is thus greatly reduced (*e.g.* in the civil hospitals of Lyons from 26 to 9 per cent., in private practice to 1 or 2 per cent.).—On the proposals of M. Balbiani for opposing phylloxera, and on the winter egg of the phylloxera of American and European vines, by M. Targioni-Tozzetti. He throws doubt on the data on which the Phylloxera Commission have proceeded, in directing effort towards the destruction of the winter-egg. M. Balbiani replies at length to his arguments, none of which, he states, are new.—Treatment of phylloxerised vines, with sulpho-carbonate of potassium in 1882, by M. Mouillefert. The surface treated was 2225 hectares, on 385 properties, and a steady increase is shown since 1877. The amount of sulpho-carbonate used was 821,317 kg.; the cost varied between 200 and 450 francs per hectare; 0·05 fr. and 0·04 fr. per stock.—Observations on the subject of the Circular of the United States Government, concerning the adoption of a common initial meridian and a universal hour, by M. de Chancourtois. He advocates the adoption of a decimal division of the day and of the circle (the latter into 400 degrees, the right angle containing 100). The ancient meridian of Ptolemy, about 31·7 degrees from that of Paris, he considers the best for the initial meridian.—On the hypergeometric functions of superior order, by M. Goursat.—On Fourier's series, by M. Halphen.—On a general property of an agent whose action is proportional to the product of the quantities in presence and to any power of the distance, by M. Mercadier.—Methods for determination of the ohm, by M. Brillouin.—Reply to a note of M. Maurice Lévy.—Researches on the relative oxidisability of cast iron, steel, and soft iron, by M. Gruner. Various plates, suspended in a frame, by their four corners, were immersed simultaneously in water acidulated with 0·5 per cent. of sulphuric acid, or sea-water, or were simply exposed in moist air of a terrace. *Inter alia*, in moist air, chromate steels were oxidised most, and tungsten steels less than mere carbon steel. Cast iron, even with manganese, is oxidised less than steel and soft iron, and white specular iron less than grey cast iron. Sea-water, on the other hand, attacks cast iron more than steel, and with special energy white specular iron. Tempered steel is less attacked than the same steel annealed, soft steel less than manganese steel or chromate steel, &c. Acidulated water, like sea-water, dissolves grey cast iron more rapidly than steel, but not white specular iron; the grey impure cast iron is most strongly attacked.—On the losses and gains of nitrogen in arable land, by M. Dehérain. The losses are due not only to the exigencies of crops, but also, and for the most part, to the oxidation of azotised organic matter. When the land is not stirred, but kept as natural or artificial meadows, the combustions are less active, and the gains of nitrogen exceed the losses. Thus a farmer will more easily enrich a soil with nitrogen by keeping it in a meadow than by prodigal manuring.—Physiological action of picoline and lutidine, by MM. de Coninck and Pinet.—New experiments on irian grafts, with a view to establishing the etiology of cysts of the iris, by M. Masse.—On the solutions of continuity produced at the moment of moulting, in the apodemian system of decapod crustaceans, by M. Nevequard.

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